ON THE SPRINGFIELD RIFLE AND THE LEDUC FORMULA*

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One of the formulae of interior ballistics found most useful, at any rate by practical ballisticians in the United States, is the formula of Leduc, which says that the velocity of a shot in the bore of a gun is graphically represented in terms of the distance travelled by a rectangular hyperbola, giving the formula:

$$v = \frac{as}{b + s}$$

where v is the velocity, s the distance travelled by the shot.

The writer had the curiosity to try this formula on the Springfield rifle. The observations were made by the gauge described in these PROCEEDINGS, **5**, July, 1919 (259–263). The mode of deducing the Leduc formula is decidedly open to criticism since it assumes the combustion to be instantaneous, and the expansion adiabatic, neither of which is true and it is perfectly obvious that powders giving curves so different as those published in the paper quoted cannot possibly give v, s curves of the same shape. Nevertheless, it turns out that for the rifle the Leduc formula answers very well indeed.

Observations were made on the time of reaching different points in the barrel by Mr. H. C. Parker, assistant in the Ballistic Institute of Clark University. The method was to put a fine wire insulated with enamel down the barrel of the rifle to a certain distance. When the shot reached it a circuit was made which made a current passing through the oscillograph. The motion of the oscillograph was photographed on a rotating drum and thus the times were obtained. The curve obtained for the actual times of reaching ten or a dozen distances was exactly similar to that shown in the paper cited above, obtained by a double integration of the pressure-time curve. The velocities were obtained from Mr. Parker's curve by a graphic differentiation, and from the known velocities and distances the formula was obtained. Even without the method of least squares the formula $v = \frac{1133s}{19.8 + s}$ answers very well where the distances are given in centimeters and the velocities in meters per second.

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